TEACHER INFORMATION

Acids and Bases

1. Editable Microsoft Word versions of the student pages and pre-configured TI-Nspire files can be found on the CD that accompanies this book. See *Appendix A* for more information.

2. To prepare the 0.1 M NaOH solution, use 4.0 g of solid NaOH pellets per 1 L of solution. **HAZARD ALERT:** Corrosive solid; skin burns are possible; much heat evolves when added to water; very dangerous to eyes; wear face and eye protection when using this substance. Wear gloves. Hazard Code: B—Hazardous.

   To prepare the 0.1 M HCl solution, use 8.6 mL of concentrated acid per 1 L of solution. **HAZARD ALERT:** Highly toxic by ingestion or inhalation; severely corrosive to skin and eyes. Hazard Code: A—Extremely hazardous.

   The hazard information reference is: Flinn Scientific, Inc., *Chemical & Biological Catalog Reference Manual, 2000*, (800) 452-1261, www.flinnsci.com. See *Appendix F* for more information.

3. Try to make a 1% solution of the materials to test. It is not too critical to be exact. Add ~10 grams of material for each liter of solution.

4. Have the students help design the list of materials to use. Try to use the same number of chemicals in each of the three classes of materials—biological organisms or tissues, biological chemicals, and non-biological chemicals.

   Good organisms or tissues to use might include blended liver, plant leaves, potato roots, yeast, fruit juices (from real fruit—not those <10% varieties!) or Euglena (if you culture them). Try to avoid oily materials—they will be difficult to clean off the probe.

   Good chemicals include starch, enzymes, gelatin, vitamin Bs or C, casein, egg white, or other simple, non-oily biochemicals.

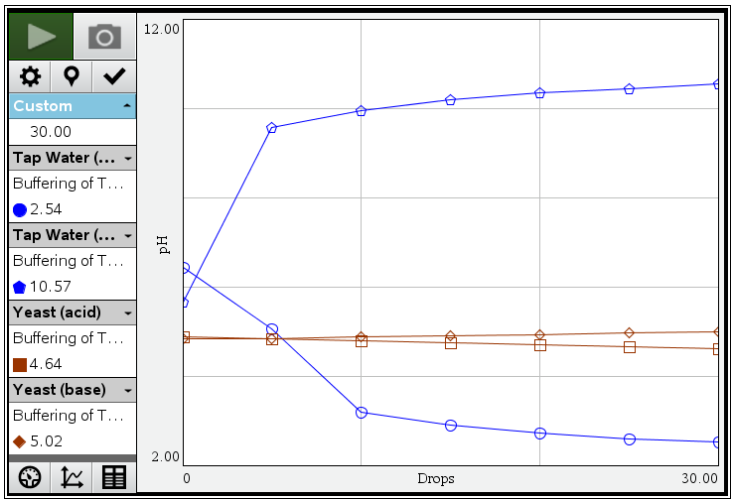
   Good non-biological materials include a mix of buffers with non-buffers. Buffers might include soda water, Alka-Seltzer, phosphate buffer, Tums, etc. An interesting combination is aspirin and Bufferin. Good non-buffers include table salt and nitrogen fertilizer. It is fun to include rocks—try marble (calcium carbonate—a buffer in acid) and quartz.

5. It is not necessary to calibrate your pH sensors, the stored calibration will work fine for this experiment.

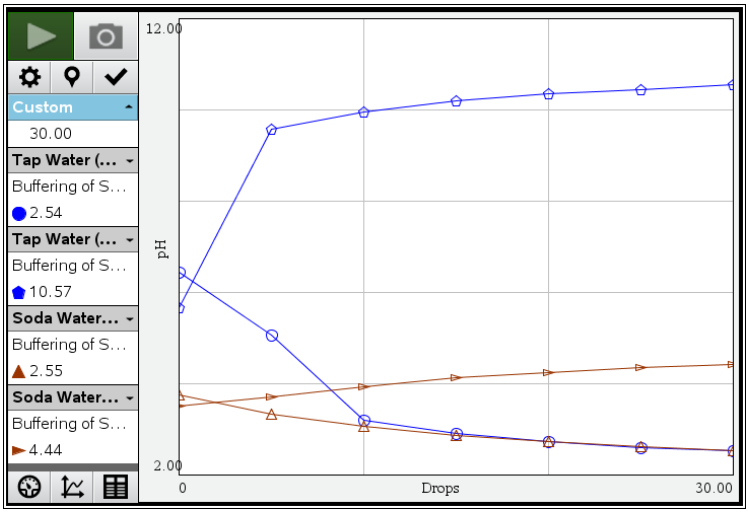
6. Vernier Software & Technology sells a pH buffer package for preparing buffer solutions with pH values of 4, 7, and 10 (order code PHB). Simply add the capsule contents to 100 mL of distilled water. You can also prepare pH buffers using the following recipes:
   - pH 4.00: Add 2.0 mL of 0.1 M HCl to 1 L of 0.1 M potassium hydrogen phthalate.
   - pH 7.00: Add 582 mL of 0.1 M NaOH to 1 L of 0.1 M potassium dihydrogen phosphate.
   - pH 10.00: Add 214 mL of 0.1 M NaOH to 1 L of 0.05 M sodium bicarbonate.

SAMPLE RESULTS

Table 1										
Material Tested	Add	pH, after adding this many drops								
		0	5	10	15	20	25	30	ΔpH	Total buffer range
Tap water	Acid	6.46	5.07	3.20	2.92	2.74	2.61	2.54	-3.92	8.82
	Base	5.67	9.59	9.97	10.21	10.37	10.46	10.57	4.90	
Aspirin	Acid	2.71	2.65	2.62	2.58	2.55	2.51	2.48	-0.23	0.38
	Base	2.76	2.76	2.79	2.82	2.85	2.88	2.91	0.15	
Vitamin B2	Acid	4.72	4.25	3.48	2.95	2.74	2.63	2.54	-2.18	5.89
	Base	6.56	8.64	9.45	9.85	10.08	10.19	10.27	3.71	
Vitamin C	Acid	2.84	2.71	2.65	2.59	2.56	2.52	2.48	-0.36	0.49
	Base	2.52	2.53	2.55	2.56	2.58	2.61	2.65	0.13	
Soda water	Acid	3.76	3.34	3.08	2.87	2.74	2.63	2.55	-1.21	2.13
	Base	3.52	3.73	3.94	4.14	4.26	4.36	4.44	0.92	
Cornstarch	acid	4.87	3.30	3.02	2.87	2.76	2.67	2.60	-2.27	7.29
	base	5.84	9.54	10.21	10.47	10.64	10.78	10.86	5.02	
Salt water	acid	4.13	3.06	2.75	2.63	2.53	2.46	2.40	-1.73	8.49
	base	4.72	10.35	10.85	11.07	11.23	11.37	11.48	6.76	
Yeast	acid	4.91	4.87	4.81	4.77	4.72	4.68	4.64	-0.27	0.43
	base	4.86	4.86	4.89	4.92	4.95	4.99	5.02	0.16	



Data for tap water (acid - ○ and base - ●) and Yeast (acid - □ and base - ■). Notice that Tap water has virtually no buffering while yeast shows significant buffering.



Data for tap water (acid - ○ and base - ●) and soda water (acid - △ and base - ▲).

Classification of Materials		
Organisms or tissues	Biological chemicals	Non-biological chemicals
Yeast	Aspirin	Soda Water
	Starch	Tap Water
	Vitamin B2	Salt Water
	Vitamin C	

Table 2		
Material	Initial pH	Rank
Aspirin	2.71	most acidic
Vitamin C	2.84	2
Soda Water	3.76	3
Salt Water	4.13	4
Vitamin B2	4.72	5
Cornstarch	4.87	6
Yeast	4.91	7
Tap Water	6.46	least acidic

Table 3		
Material	Total Buffer Range	Rank
Tap Water	8.82	Greatest change
Salt Water	8.49	2
Cornstarch	7.29	3
Vitamin B2	5.89	4
Soda Water	2.13	5
Vitamin C	0.49	6
Yeast	0.43	7
Aspirin	0.38	Least change

ANSWERS TO QUESTIONS

For Sample Answers to the questions in this lab, please contact Vernier Software and Technology at swnanswers@vernier.com